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Industrial work placement in Higher Education: a study of civil engineering student engagement

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Abstract

For civil engineering undergraduates, short-term industrial work placement provides an invaluable learning experience. Notwithstanding the near universal endorsement short-term placement programmes receive, the resultant experience is rarely articulated through the student voice. This paper provides analysis of questionnaires (n=174) returned by placement undergraduates studying civil engineering at four Higher Education Institutes (HEI's) in the West of Scotland. Commentary captures industrial placement statistics, employability skill-sets and preliminary semantic interpretation of participant testimonies. Whilst the student journey to becoming a professional civil engineer is undoubtedly enhanced by short-term industrial placement, the findings disclose opportunities for university and industry to challenge and affect pedagogical discourse in relation to personal and professional development. The discussion is likely to resonate beyond civil engineering and serve as a timely reminder of the necessity to periodically revisit and re-invigorate academia / industry curriculum partnerships.

Keywords: Industrial Placement; Civil Engineering; Engineering Education.

Introduction

For civil engineering undergraduates, the opportunity to spend a period of time in formal industrial work placement provides an invaluable learning experience (Little and Harvey, 2007, HEA, 2013). For this study (n=174), short-term civil engineering work placement was a maximum of eighteen weeks with an average industrial placement period of twelve weeks. A short-term industrial placement is very important for the undergraduate (Spinks et al., 2006) or 'civil engineer in training' (Murray et al., 2015), "enabling students to gain practical experience of industry as part of their education" (RAE, 2007 p.6). Not only is industrial placement likely to reinforce prior academic studies, students working as a co-opted member in a 'live' engineering environment tackling engineering problems and liaising with highly qualified engineers will in all likelihood shape expectations, shift perceptions and enhance individual comprehension of the civil engineering profession.

Whilst undergraduate civil engineers receive encouragement and support from university to secure industrial placement (Temple et al., 2014), student uptake remains largely unspecified. Indeed, student industrial placement is often perceived as either extra-curricular (activities independent of the university (Harvey, 2001)) or alternatively co-curricular (related structured activities pursued in addition to the normal course of study (Burt et al., 2011)). Indeed,

anecdotal evidence would indicate that short-term industrial placement is rarely anchored within the official civil engineering programme.

Not only is information on industrial placement and student engagement patchy (Lowden et al., 2011), the resultant workplace experience, notwithstanding a few notable exceptions (see Lock et al., 2009, Jawitz et al., 2005) is seldom articulated through the student voice. Students may be required to write a reflective report on their placement experience and whilst this exercise provides constructive and critical retrospection for personal and professional development, without curricula support these valuable and contextually rich 'workplace stories' seldom extend beyond a cursory critique (Smith and Trede, 2013). Indeed, with little or no detailed exploration it remains problematic to determine work placement patterns, predict pedagogic challenges and improve undergraduate engagement.

Securing industrial work placement is not the only challenge. Pressure on universities to operate across a diverse range of performance metrics has arguably loosened traditional industry / academia ties (Christensen and Erno-Kjølhed, 2011). Industrialists and academics alike have repeatedly expressed disquiet at the ongoing fragmentation of this key bilateral academic / industry accord (Snell, 1996, Barr, 2008, Whitelaw, 2016, Pilcher et al., 2017). A sentiment endorsed by award winning structural engineer Chris Wise (Whitelaw,

2016 p.48); “we need much greater industrial involvement in the education process, not just as visitors but in a way that allows significant involvement in curriculum development.”

Given the scope of potential inhibitors to ‘meaningful industry engagement’ (Broadbent and McCann, 2016) a ‘silver-bullet’ solution remains unlikely. Visiting professors and teaching engineers (Broadbent and McCann, 2016) can embellish the curriculum with inspirational examples of engineering case studies. Visits to construction projects (Murray and Tennant, 2016a), industrial mentoring of students (Murray et al., 2015) and drawing upon testimonies from past ICE presidents (Murray and Tennant, 2016b) offer alternative educational approaches designed to ensure students develop employability capital and anticipatory socialisation about their chosen career path. Nonetheless, for an authentic experience of civil engineering, students need to be immersed within the ‘theatre’ of project environments where their explicit core engineering knowledge is ‘road-tested’ and mediated by a tacit understanding of the ‘grounded’ realities of everyday civil engineering practice.

Whilst discussions on ways academia can facilitate integration of theory with practice (Spinks et al., 2006) are plentiful, varied and occasionally creative, the positive educational, personal and professional impact of student work placement receives near universal approval (Little and Harvey, 2007). Not only

is industrial placement important for the student's academic cognition, benefits also include refinement of transferable skills and development of professional values. Placement significantly improves employability (Lowden et al., 2011) and perhaps more crucially social mobility (Blackmore et al., 2016). The heightened prominence of employability (Lowden et al., 2011, Pegg et al., 2012, Creasey, 2013), student mobility and by extension student engagement with industry is beginning to inform key policy debates on teaching excellence, student transition and destinations of leavers from Higher Education (DLHE). Despite UK Government encouragement for work ready graduates (BIS, 2016), critics warn against the vocationalization of university education at the incumbent risk of producing 'compliant 'knowledge workers', and neglecting to nurture the critical mind' (McEwen and Trede, 2014) by means of thought-provoking pedagogy.

Following this introduction, the subsequent section explores traditional links between scientific theory and engineering practice and the influence this knowledge exchange relationship has had on HE discourse within civil engineering education. In addition, the concept of 'learning' technical competence coupled with professional values is also examined from the perspective of the 'civil engineer in training' (Murray et al., 2015). The research strategy and method is explained with limitations and assumptions clearly

stated. The findings and discussion section presents a snapshot of student workplace experiences. Analysis reveals patterns of industry engagement, discloses noteworthy statements and identifies a key intervention for enhancing contextual learning before, during and after a student's industrial placement period. The conclusion offers avenues for further research and reinforces the requirement for universities to explore experiential learning opportunities that contextualize academic cognition and 'bring to life' the excitement of a professional career in civil engineering.

Civil engineering theory & practice

'Learning on the job' is a notable characteristic of the construction craftsmanship education and frequently associated with the pupillage apprenticeship system (Snell, 1996). This time-honoured approach to practice-led instruction underscored the training of civil engineers through exposure to 'old timers' in drawing offices and at the project coal face. Buchanan in his paper 'The Rise of Scientific Engineering in Britain' (1985 p.219) noted that the late 18th to mid-19th century was the era of job-related, practice-led education with little importance given to "theoretical instruction and examination". However, interpretation of educational and professional competence shifted in line with society's growing faith in science and scientific thinking (Ferguson, 1992). Consequently by the late 19th and early 20th century, the focus on

scientific thinking and academic competence (MacLeod, 2010) had become progressively prominent.

Reasons for change in professional education and training are both complex and layered. There are perhaps two dominant drivers; firstly, a professional obligation to protect clients and by extension society from a growing number of rogue traders (Bowyer, 1993). Secondly, the ever-increasing complexity of projects necessitated the augmentation of practice-led instruction with scientific principles and academic expertise (Buchanan, 1985). Indeed, catastrophic engineering failures such as Robert Stephenson's Dee Bridge collapse in 1847 (Buchanan, 1985) and the Tay Rail Bridge disaster in 1879 (Ferguson and Chrimes, 2011) proved instrumental and can be linked to the establishment of official civil engineering curriculum at UK universities. Anxiety regarding professional reputation and technological advancement has arguably coalesced over time to simultaneously raise and validate professional engineering competency.

The maturation of 'joint-interest' between engineering practice (industry) and scientific theory (academia) maintained a workable equilibrium until post Second World War. In the early 1960's UK Government sought to intervene in a Higher Education (HE) system that excluded many talented young adults (Robbins, 1963, Gibney, 2013). Although the Robbins Report (1963) focused

primarily on increasing student access and improving gender diversity within UK HE provision and did not target the decoupling of theory from practice directly, many of the adopted policies and subsequent HEI practices began to challenge the status quo and recalibrate long-established bilateral academic/industry relations. As a marker of substantive change, by the late 1960's university students could graduate and commence employment in an engineering discipline in which they had no prior practical experience.

Over the past fifty years decoupling has continued (Barr, 2008, Arlett et al., 2010, Alplay and Jones, 2012, Tennant et al., 2015). Given ever-increasing pressure on universities to pursue alternative income streams, principally research and enterprise (R & E), the primacy of 'vocational' and 'contextual' learning bridging theory and practice has become progressively tenuous (Little and Harvey, 2007). Acquiescence for generic 'engineering' programmes (Webster, 2006) catering for a mass HE philosophy stands in stark and impoverished contrast with the views of Charles Hawksley (1872), a past president of the Institution of Civil Engineers (ICE);

“that you will never become a practical engineer on theory alone, take every opportunity which presents itself of becoming apt in surveying and levelling, and in the methods employed in the setting out of works; learn the uses and applications of tools ; make yourselves

able to distinguish a good material from a bad material, good workmanship from bad workmanship, sound ground from treacherous ground, good puddle from bad puddle, good mortar from bad mortar, and a good workman from a bad workman. This knowledge is not to be obtained in a school, a college, or an office, and cannot be learnt from books.... Be not afraid of soiling your hands or dirtying your boots, but be in every other respect-in thought, feeling, and conduct - a gentleman (Hawksley, 1872 p.350 - 351).

Hawksley (1872) was clearly an advocate for situated cognition as a means to 'road-test' an engineer's theoretical knowledge. Whilst it would be unreasonable to suggest a return to traditions of the artisan builder and an education system based wholly on practice-led tuition, industrial work placement as an integral part of the student learning experience does have significant technical, personal and professional benefits (Little and Harvey, 2006, Little and Harvey, 2007). The opportunity to road-test knowledge and theoretical understanding is arguably indispensable in transition to becoming a professional civil engineer.

Becoming a professional civil engineer

For school leavers contemplating a career in civil engineering, their professional journey commences with enrolment at university (JBM, 2009). Whilst this truism is apt for many professional disciplines, for undergraduates in civil engineering

this statement of fact resonates more profoundly. Despite recent initiatives to introduce civil engineering at 'grassroots' level (see ICE, 2017), the pathway to becoming a professional civil engineer is not addressed prior to university enrolment (Murray and Tennant, 2014) in any substantive manner.

Anecdotal evidence indicates that the majority of first year civil engineering undergraduates enrolling at university are both technically and professionally naïve (Murray and Tennant, 2014). Given this dual academic and professional naivety, a meaningful civil engineering curriculum ought to address and give undergraduates access to both academic and situated cognition. Academic cognition will focus on the scientific principles, computation and abstract skills-set, whereas situated cognition will refine transferable skills, introduce 'context' and offer 'useful' application of academic cognition in a practice-led civil engineering environment. For vocational disciplines such as civil engineering, academic and situated cognition are inextricably linked. Addressing one devoid of the other will only serve to validate an impoverished student learning experience.

Indeed, Johri and Olds (2011) refer to undergraduates forming their identity through participation within a community of practice (CoP) of professional engineers. Drawing on time-honoured training traditions, the notion of placement students being 'inducted' in a CoP through legitimate peripheral

participation (Lave and Wenger, 1991) is arguably akin to the original pupillage-apprenticeship system. Although beyond the scope of this paper, the introduction of Graduate Level Apprenticeships (GLA) is arguably recognition of the requirement to integrate theory with practice and is well-placed to engender a community of 'learning' and practice.

In addition to constructing their professional identity and competence through industry exposure, several studies (Lamb et al., 2010, Pegg et al., 2012) have found strong connection between undergraduate industrial placement experience and future employability. Drawing upon the findings of Pegg et al, (2012 p.45) "there is strong evidence to indicate that authentic work experience contextualises learning, has a strong influence on graduate employment" and where possible "should be integrated into course curricula." In order to maximise learning for future employability it is crucial that situated cognition is a pedagogically supported student experience. This would include critical reflection, detailed analysis and considered articulation of academic, personal and professional learning. However, embedding workplace learning in the official civil engineering curriculum is likely to necessitate a change to epistemic beliefs of students and academics alike.

Research strategy

This is a diagnostic paper, exploring the educational added-value of short-term industrial placement undertaken by civil engineering students. All students participating in this study were enrolled at one of four Higher Education Institutions (HEI's) within the West of Scotland; namely, University of Glasgow (UG), University of Strathclyde (UoS), Glasgow Caledonian University (GCU) and University of the West of Scotland (UWS), see table 1 (n = 489). Only GCU and UWS offer the option of a credit bearing work placement module. For both GCU and UWS, the optional workplace learning (WPL) module is arguably a vestige of the university's pre-1992 technology status, where sandwich degrees and industrial placement were once a distinctive and valued characteristic of Central Institutions (Scotland) and Polytechnics (England, Wales and Northern Ireland) (Little and Harvey, 2007).

Table 1: Summary of participating universities

Given the individual and largely subjective nature of experiential and tacit learning associated with industrial workplace experience, a qualitative evaluation of student engagement was deemed appropriate. Encouraging dialogue is an important part of quality and excellence in HE learning and teaching and contributes to the call for student engagement through partnership (Healey et al., 2014). The individual accounts and brief testimonies of

respondents illuminate a facet of student learning that remains largely in the 'shadows' and thus frequently overlooked.

Research method

The research method adopts a questionnaire data gathering technique. Given the potential size of the student population and the geographical scope, it was agreed that a questionnaire would provide the best opportunity for capturing a large sample size, provide consistency, maintain validity and address unity of research objective across four university campuses. The issue of expediency and research logistics also had a bearing on the selection of a suitable data gathering technique. The potential contribution of semi-structured interviews has not been ignored and may be drawn upon in future to enhance further pedagogical understanding of industrial work placement studies.

The design of the questionnaire was the outcome of numerous iterations. The questionnaire format was prepared by the lead author and underwent peer review by the three co-authors. This resulted in a period of ongoing improvement and modification until all authors were satisfied with the aims, structure, content and presentation of the questionnaire.

All questionnaires were completed in autumn 2015. Across the four university campuses, there were 609 students enrolled on a second, third, fourth or fifth

year HE programme in Civil Engineering, 489 students participated in the questionnaire. The response rate equates to 80.30% of eligible students participating in the research. First year students in transition from secondary education to university were excluded. It was considered very few 'fresher's' would have had the opportunity to participate in civil engineering work placements.

The narrative draws upon short-term industrial experience and asked a number of prescribed questions. Students were invited to provide general information related specifically to industrial placement classification; namely, (1) civil engineering / non civil engineering or no placement experience, (2) type of employment; namely, consultant / contractor or client, (3) placement location and (4) placement timeframe. Thereafter students were asked to rate using a Likert scale (1-5) what extent did the work placement experience improve knowledge and appreciation for a range of transferable skills. Students were also asked a number of questions that connect university life with placement experience and asked to rate these on a Likert scale ranging from strongly disagree (1) to strongly agree (5). Finally, respondents were invited to extend a brief testimony reflecting on their civil engineering placement experience.

In accordance with ethical best practice, participation in the survey was voluntary. Prior to partaking in the survey, all participants were given an

information sheet, contact details and privacy statement. Students were also informed that they could withdraw consent from the survey at any time without reason. Norton (2009 p.181) cautions academics of the potential for “undue influence or coercion” when utilizing a captive student population for pedagogical research (Ferguson et al., 2004). In retrospect, the high response rate was achieved by distributing the questionnaires at the start of a lecture period. Inadvertently, peer pressure may have predisposed respondent participation. All data has been anonymized, no personal or company names have been used in order to protect and respect the privacy of participants and respective placement organizations.

Despite the numerical benefits of a large sample size (n=489) it is important to acknowledge limitations and assumptions associated with this study. The study captures workplace experience for university students enrolled on a civil engineering programme; all other built environment disciplines such as construction management, quantity surveying, architectural studies and urban planning are excluded. Student testimonies may be classified as ‘semantic content’ and offer description as opposed to detailed thematic analysis (Braun and Clarke, 2006). Whilst findings from the study remain rooted in time and place, it is anticipated that themes identified for discussion will resonate with a broader audience.

Findings & discussion

The placement questionnaire is designed with three distinct sections; namely A, B and C. Initial instructions request students to complete questionnaire section A: if they have undertaken a civil engineering work placement over the period stipulated, complete questionnaire section B: if they have undertaken a non-civil engineering employment / voluntary work (part time or full time) over the period stipulated or alternatively, complete questionnaire section C: if they did not undertake work placement, employment / voluntary work over the period stipulated.

A student population breakdown

A total of 489 out of a possible 609 students participated in the questionnaire (80.3%). Reviewing the questionnaire sections completed, 174 (36%) students recorded a civil engineering industrial placement over the stipulated time period, 236 students (48%) experienced employment in a non-civil engineering capacity and 79 students (16%) were neither in civil engineering nor non-civil engineering employment, see Table 2. For the objectives of this paper, only findings from Section A (Civil Engineering placement) will be presented and discussed.

Table 2: Student population sample: a breakdown

The findings disclose that the majority of students (48%) secured non-civil engineering employment or voluntary work experience. In contrast, a significant minority (36%) of students recorded a civil engineering industrial placement. Whilst those recording a civil engineering placement remain numerically in the minority, the size of the group (>30%) is large enough to observe. Distilling civil engineering industrial workplace data (n=174), it is evident that the percentage of students securing civil engineering work placement increase as they progress from second year (BSc / BEng) to fifth year (MEng).

Reviewing the data, 15 out of 151 second year students (10%) recorded a civil engineering industrial work placement. For third year students, the figure rose to 38 civil engineering work placements from 133 respondents (28%), fourth year recorded 76 civil engineering work placements from 150 respondents (51%) and 5th year (MEng) 45 civil engineering work placements from 74 respondents (61%). These figures (re: 10%, 28%, 51% and 61%) illustrate sizeable student engagement with a diverse range (re: consultant, contractor and client) of civil engineering organizations.

Student responses (n=174) disclose that 49% of civil engineering industrial work placement was with a consultancy organization, 45% with a contracting organization and 6% with client organizations. Placement locality for the overwhelming majority of students remained in the West of Scotland. From the

student population, 66% of civil engineering students on industrial work placement were located in the West of Scotland, 21% were placed in Scotland (outwith the West of Scotland) and 13% of students secured placement in the UK (outwith Scotland) or alternatively overseas. Regardless of organization type or locality, average length of tenure was 12 weeks.

Whilst the data set is constrained in terms of geographical location and records a small sample of HEI's (four universities), findings may be generalized beyond these boundaries. The large population sample although with limitations is arguably indicative of civil engineering programmes and undergraduates in general and provide an authentic snapshot of industrial engagement and the typical challenges facing work placement students, their host companies and educational institutions.

Transferable skills

Challenges facing students, companies and HEI's are diverse. For HEI's, engineering knowledge and understanding (technical) continues to dominate programme delivery whilst for companies and their prospective employees there is repeated calls for greater attention to be given to soft skills (non-technical) and development of transferable skills common to the workplace (Mo et al., 2007, Mo and Dainty, 2007). Addressing the theme of transferable skills, students were asked to rate; using a Likert scale 1–5 (one = not at all / five = a

lot) the following question: “Over your placement, to what extent did you improve your knowledge and appreciation of the following transferable skills?”

The seven transferable skills listed were drawn from a representative sample of literature sources (Mo et al., 2007, Archer and Davison, 2008, Matsouka and Mihail, 2016) and are reflective of the transferable skill-set routinely associated with industrial placement, added educational value and employability capital.

The transferable skills listed below capture both hard engineering competence (technical) and soft employment attributes (non-technical). Skills such as (1) technical knowledge, (5) risk management and (6) problem solving relate to hard engineering skills that will typically be explicitly addressed in the official curriculum. In contrast, (2) communication skills, (3) team working and (4) commercial awareness have a individual characteristic and may be classified as soft employment skills. A transferable skill such as (7) creative thinking arguably requires a blend of hard and soft skills and will draw upon technical competence and contextual awareness for unique and complex situations. A breakdown of the mean results per student cohort can be seen in Table 3. The average rating is based on 174 respondents and not solely on aggregate year figures.

Table 3. Student rating: transferable skills

Students considered ‘communication skills’ as the most significant improvement in transferable skills (4.27) with team work (4.18) narrowly behind. It is

interesting to register that 'soft skills' rated higher than 'hard skills' such as 'problem solving (4.03) and technical knowledge (4.02). These findings dovetail neatly with current employability debates given that employers place high importance on communication skills (Vincent & Borthwick, 2012) and ancillary soft skills such as team working (Archer and Davison, 2008 p.7). This emphasis on 'employability skills' (Archer and Davison, 2008, Temple et al., 2014, CBI, 2016) raises key questions for HEI's. Not only does programme content and delivery require prescribed engineering discipline that will satisfy accreditation criteria but also requires the co-development of non-technical skill-sets frequently sought by prospective employers.

Respondent appraisal of 'creative thinking' skills (3.74) receives a lower-ranking evaluation in comparison with other transferable skills. Context is important and the likelihood of curtailed task and role responsibilities during placement has potentially restricted meaningful engagement in creative thinking environments. The subsequent lack of structured retrospection may indicate participant failure to recognise and label key learning experiences. Nonetheless, reviewing the spectrum of transferable skills data; the added value of industrial work placement is clearly evident and discloses a strong association with recognized literature (Little and Harvey, 2006, Little and Harvey, 2007).

Contribution to learning

In addition to transferable skills, students were also asked to consider auxiliary attributes that connect university life with industrial work placement experience and rate six 'contribution to learning' factors on a Likert scale 1–5 (one = strongly disagree / five = strongly agree). These were informed from the collective experience of the author(s), supported by literature (Murdoch, 2004, Harding and Thompson, 2011) and capture discrete shifts in student perception and perceived added-value following short-term industrial placement. The six questions cited were as follows: (1) My summer placement has helped confirm my intention to take up a graduate job in civil engineering? (2) My summer placement has motivated me to be more conscientious in my university studies? (3) During my summer placement I used knowledge and or skills from my university studies? (4) I have recorded my placement experience in a reflective report? (5) If I record my experience in a formal report, I would like to receive formal credits that contribute to my degree qualification? (6) University academics are interested in my summer placement experience? A breakdown of results can be seen in Table 4. The average rating is based on 174 respondents and not solely on aggregate year figures.

Table 4. Student rating: contribution to learning

The data reveals the importance of industrial work placement in 'confirming' / 'reinforcing' a professional career choice in civil engineering (4.48). In addition, the work placement experience has been a strong motivator, encouraging students to enhance engagement and performance levels at university (4.31). Whilst the findings do not explore nor disclose empirical evidence of substantive improvement in university grades, the 'motivation to study' factor it is indicative of previous work-based learning outcomes (Little, 2006, Harding and Thompson, 2011). Harding and Thompson (2011 p.12) cite one undergraduate describing "how their marks went up by 8% after their placement, which they attributed to the practical experience they had gained."

It is worthy of note that second year (4.79) and third year (4.22) motivation for university studies recorded the highest mean value, whereas in fourth and fifth year this factor dipped to second highest and was replaced by a 'confirmation' of intent. Findings imply placement students switched their educational orientation from progression (for continuing students) to transition (outduction and future professional employment). The transformation in student 'self-perception' from 'engineer in training' (Murray et al., 2015) to 'engineer in work' suggests that given the opportunity of industrial work placement, students are 'mindful' in preparing for transition to full-time 'professional' employment. The shift in cognitive disposition is likely to lessen 'transition shock' (Gale and

Parker, 2014) and sanctions prior notions of anticipatory socialization (Sang et al., 2009), shaping realworld expectations, perceptions and comprehension of becoming a professional civil engineer.

The merits of industrial placement extend beyond the technical, personal and professional development of individual students. The university and placement organization(s) also benefit from the partnership. For university, it brings in to sharp focus three distinct work-based learning attributes; namely, (1) academic cognition - an opportunity to 'road-test' technical knowledge and problem-solving, (2) situated cognition - a facilitator of transferable skills that employers' value and (3) anticipatory socialization – developing professional values and preparing students for outduction and transition – see Table 5, re: student testimonies. For the host organization(s), short-term placement opportunities may augment recruitment strategies and 'audition' students prior to full-time employment. As declared by one questionnaire respondent, '*I got a job after graduating*'.

Student testimonies

Further constructive endorsement is provided by student testimonies (presented in *italics* & key words *underlined*). Whilst future detailed thematic analysis may disclose “underlying ideas, assumptions and conceptualizations” (Braun and Clarke, 2006 p.84), it remains clearly evident that the overwhelming majority of

students extended positive descriptions and found the placement experience worthwhile and fulfilling (*boosted my confidence*), exciting (*it was brilliant*) and meaningful (*really helped me understand what a civil engineer does in the workplace*). Student testimonies also make explicit connections between taught theories (*good to use the skills learnt at university*) and industrial practice (*valuable insights into industry practice*). There would appear to be genuine sentiment that students have been both enthused by the placement experience (*really enjoyed it, loved the work and the team*) and emboldened (*a good experience that has confirmed my intention of becoming a civil engineer*).

Testimonies also suggest students drew on opportunities to refine their academic cognition of largely abstract concepts as applied in practice (situated cognition) (*great to see how everything I've learned at university is applied in reality*) as well as picking up on 'gaps' (*it was a useful experience as site work was not what I expected and highlight a lot of construction issues not highlighted in academic work*) that may exist in the official curriculum or are yet to be covered (*very useful and a great opportunity to gain valuable insights into industry practice. It allowed me to gain knowledge about things yet to be learned at university*).

In addition to the constructive responses cited, student testimonies also hint at opportunities to enhance the placement experience. Recurrent topics include,

induction (*better introduction at the beginning*), variety (*more varied experience in different department; more varied work within the company*), length of placement period (*could have been longer; a longer term of employment*) and university engagement (*good idea if university helped/made it an incentive; receive credits for report or similar; better employer university ties*). Nonetheless, the most frequent observation was in relation to placement structure. Students appear to desire a more formalized and prearranged placement experience (*a more structure approach and entry / exit meeting report; better structure and responsibility*). Closer collaboration between industry and academia to establish key objectives, identify areas of responsibility and developing an overarching and coherent plan may assist students to settle quicker and make sense of their work-based learning environment and newfound membership of a community of practice.

Whilst the testimonies presented offer a snapshot of student engagement, they are indicative of respondent feedback to their industrial work placement period. The student testimonies (*italics*) and key words (*underlined*) capture the essence of their workplace experience and may be interpreted as building blocks for 'making sense' of civil engineering in practice (see Table 5). For example, making sense of the knowledge they have gained re: academic cognition (*it has made me look forward to university*), making sense of realworld

engagement re: situated cognition (*gained practical knowledge in civil engineering*) and making sense of the civil engineering profession they have joined re: socialization (*my placement really helped me understand what a civil engineer does in the workplace*). Yet, it is arguably a key ‘contribution to learning’ attribute vital for sense-making that appears to be largely overlooked, namely; reflective analysis.

Table 5. Student testimonies: making sense

Reflective analysis

Whilst findings assert student industrial placement experience is overwhelmingly positive and outcomes concur with widely held opinion (Little, 2006), one notable weakness drawn from the study is the paucity of structured reflective analysis. Described by Schon (1996) as an ‘act of professional artistry’, critical reflection is an analytical examination of self (Smith, 2011) that not only distils ‘first-hand’ experience but also facilitates understanding and makes sense of action and events through reasoned observation. For industrial placement students, encouraging engagement and development in the skill of reflection “facilitates the linking of theory and practice,” (Roberts, 2012 p.57). Devoid of pedagogical intervention and counselling before, during and after placement, the content, process and premise reflection (Mezirow, 1991) of industrial experience may lack context, complexity and critical reflection

(Samuels and Betts, 2007). This is likely to diminish the added value of road-testing prior academic cognition.

Students typically have difficulty engaging constructively with reflective practice (Doel, 2009). Indeed, unsupported efforts to acquire professional competency in reflection and reflective thinking routinely fail (Roberts, 2012). Without considered intervention, the student 'sense of meaning' rarely extends beyond superficial accounts of industrial experience, electing to reciting events, occurrences and outcomes that are devoid of any deep cognition (Bain et al., 1999, Samuels and Betts, 2007). To encourage future diffusion of reflective practice, a number of potential barriers require to be highlighted.

First, students may not recognise the 'contribution to learning' value of reflective practice nor indeed be proficient or confident in that style of learning. Second, the often 'messy' and context laden workplace environment may create confusion, uncertainty and levels of complexity that students find difficulty navigating. Third, the multi-sensory experience of industrial placement is at odds with traditional university learning frameworks where knowledge is compartmentalized and delivered with prescribed logic. In contrast to a mainstream reductionist approach, the professional engineer is required to handle and evaluate incomplete information drawing not only on knowledge but more importantly, intuition (MacLeod, 2010). Finally, the highly social nature of

reflective practice requires confidence and self-efficacy (Smith and Trede, 2013). To facilitate this mode of learning, the development of key learning tools coupled with mentoring and intervention from civil engineering faculty is paramount.

From an academic perspective it remains troublesome that opportunities for developing reflective thinking throughout the student learning experience are not institutionalised. Introducing reflective learning strategies before, during and after industrial placement offers an alternative 'constructivist' pedagogy (Kettle, 2013), which echo with the 'grounded' realities of everyday civil engineering practice. Not only is industrial work placement a valuable learning experience (Little and Harvey, 2007) it is also an opportunity to facilitate shifts in pedagogy and student learning styles that support and empower student transition from university to becoming a professional civil engineer.

Reflective thinking is a key constituent of a faculty learning strategy that puts the 'practice' of civil engineering at the core of student knowledge, understanding and professional development and will aid students to connect Personal Development Planning (PDP) with their Initial Professional Development (IPD) and Continuing Professional Development (CPD). Indeed, the Institution of Structural Engineers (IStructE, 2015, p.2) specifically recognises that "all relevant experience may be taken into account, including

pre-graduate experience from 'sandwich', part-time or vacation work." It is also worth noting that to gain Chartered Engineer (CEng) status; all candidates are required to submit a professional reflective review. The HEA report 'Industrial Placements for Engineering Students: a Guide for Academics' (Newman et al., 2009), clearly emphasizes this important point.

Conclusion

The report findings are timely given that the Teaching Excellence Framework (TEF) has brought in to sharp focus quality of learning and student destinations upon graduation. The requirement for universities to facilitate and 'chart' student transition from induction to outduction and beyond has raised questions about faculty management of learning activities characterized as co-curricular and extra-curricular. Traditional light-touch student-industry engagement strategies are likely to be revisited and revamped in an effort to embed industrial placement within a contemporary engineering curricula. Moreover, it will be necessary to challenge the epistemic beliefs of students and academics alike so that inclusive pedagogy is employed.

This paper makes three notable contributions: (1) it provides a statistical snapshot of civil engineering placement in both time (summer 2015) and place (West of Scotland), (2) it shines a spotlight on contextual learning and gives students a voice and (3) signpost opportunities for pedagogical refinement

especially in relation to reflective thinking. Student feedback on industrial placement is overwhelmingly positive. It is clearly evident that students remain very satisfied with their civil engineering placement experience. However, faculty could do more to enhance current provision through a progressive approach to preparing students for placement, in placement, upon return to university (progression) and for transition (outduction) to professional employment. The apparent paucity of structured academic instruction and counselling in relation to reflective thinking remains a missed opportunity. This is hindered by an apparent dearth of discussion as to how students (Fryne et al., 2012) supported by engineering faculty (Montford et al., 2014) establish and develop their personal epistemic and ontological assumptions and the manner by which these beliefs shape academic and situated cognition.

The challenges highlighted extend beyond civil engineering and are pertinent for many vocational programmes. Demand for placements continues to be higher than what industry provides and the current political and economic uncertainty that prevails may witness employers offering ever-fewer placements. The benefits of short-term industrial placement recorded across the spectrum of academic, personal and professional learning serves as a reminder for building stronger academia / industry curriculum partnerships. Not only will closer collaboration and increased opportunities for industrial work placement

have positive outcomes for the student population as evidenced, it will help placement companies identify, recruit and retain professional staff whilst simultaneously facilitate the employability and social mobility ambitions of HEI's and wider UK Government policy-makers.

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Table 1: Summary of participating universities

HEI	Programme of Study: Civil Engineering	Total Number of Respondents
University of Glasgow (UoG)	Five year undergraduate civil engineering programme (MEng.) Industrial work placement extra-curricular.	No.: 104
University of Strathclyde (UoS)	Five year undergraduate civil engineering programme (MEng.) Industrial work placement extra-curricular.	No.: 217
Glasgow Caledonian University (GCU)	Four year undergraduate civil engineering (BSc Hons) programme. Industrial work placement co-curricular. Industrial work placement 60 credit optional module in trimester 1 of level 3.	No.: 55
University of the West of Scotland (UWS)	Four year undergraduate civil engineering (BEng Hons) programme. Industrial work placement co-curricular. Industrial Work Placement Learning (WPL) module available for a BEng (Hons) Sandwich Award.	No.: 113

Table 2: Student population sample: a breakdown

Year	Section A: Civil Engineering Placement	Section B: Non-civil engineering / voluntary	Section C: Not working	Total Sample	Total Enrolled	Sample as % of total enrolled
2nd	15	101	35	151	179	84%
3rd	38	66	29	133	168	79%
4th	76	61	13	150	188	80%
5th	45	8	2	55	74	74%
Totals	174	236	79	489	609	80%
% of sample	36%	48%	16%			

Table 3. Student rating: transferable skills

	(1) Technical Knowledge	(2) Communication Skills	(3) Team work	(4) Commercial Awareness	(5) Risk Management	(6) Problem Solving	(7) Creative Thinking
Yr.2	4.13	4.47	4.33	4.27	4.20	4.27	3.80
Yr.3	3.79	3.95	3.92	3.68	4.08	3.66	3.24
Yr.4	4.00	4.39	4.25	4.00	3.75	4.08	3.84
Yr.5	4.22	4.36	4.22	4.18	3.98	4.20	3.96
Ave: Rank:	4.02 (4 th .)	4.27 (1 st .)	4.18 (2 nd .)	4.00 (5 th .)	3.92 (6 th .)	4.03 (3 rd .)	3.74 (7 th .)

Table 4. Student rating: contribution to learning

	(1) Confirm my Intention	(2) Motivated University Studies	(3) Used University Knowledge	(4) Recorded Reflective Report	(5) Formal Recognition	(6) Interested Academics
Yr.2	4.64	4.79	4.07	3.21	3.64	4.07
Yr.3	4.11	4.22	3.84	2.73	4.19	3.49
Yr.4	4.53	4.37	4.21	3.05	3.95	3.60
Yr.5	4.64	4.13	3.93	3.29	4.07	3.84
Ave: Rank:	4.48 (1 st .)	4.31 (2 nd .)	3.87 (4 th .)	3.06 (6 th .)	4.01 (3 rd .)	3.68 (5 th .)

Table 5. Student testimonies: making sense

<div>Key Words</div> <div>Learning Attributes</div>	Knowledge	Understand	Skills	Workplace	Reality	Practice	Confidence	Valuable	Useful	Civil Engineer	Team	University	Intention	Enjoyed		MAKING SENSE
(1) Academic Cognition	✓	✓	✓					✓	✓			✓		✓		✓
(2) Situating Cognition	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓		✓
(3) Socialization (Professional)				✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓